DIP #574

Quick and Dirty Emergency Medicine For The USMLEs (Part 3)

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Welcome to Episode 574 of the Divine Intervention Podcast. In this podcast, we're going to be continuing the series on quick and dirty emergency medicine for the USMLE, quick and dirty emergency medicine for the USMLE.

C-spine Imaging

So what should you do on your exams when there is a concern, especially when a person falls from a height or whatever? What is one thing we're always worried about? Well, obviously, we're worried about C-spine trauma. We're worried about cervical spine trauma.

So typically, what should you do? They will ask, "What's the most appropriate next step in management for ruling out cervical injury?" What should you pick on your exams? I really hope you're going to pick the answer that says to do a cervical X-ray.

And again, despite what many resources say to use a CT scan, I wouldn't do a CT scan on the exam. I would only do a CT, if for some reason a cervical X-ray is not giving us an answer — because the thing is, despite what many people would have you believe — cervical X-rays are actually very sensitive. In fact, they are more than 90% sensitive for picking up C-spine trauma.

Atlantoaxial Instability

And I guess as an added bonus for you all listening to this podcast: who else should get a cervical X-ray on your exams? Well, it should be the people that can have atlantoaxial subluxation. Sometimes they call it atlantoaxial instability. Sometimes it's called C1–C2 subluxation.

So who are these people? Well, these are going to be people that have rheumatoid arthritis, people that have Down syndrome, people that have ankylosing spondylitis. Remember, these people have a very high risk of that C1–C2 subluxation.

Cauda Equina

Now, what should you consider in a trauma situation on your exams where the patient has incontinence and they have decreased rectal tone? They say you stick your hand in their anus and you don't get that squeeze back.

And they tell you that the person has impaired sensation in the sacrum, impaired sensation in the perineum. What should you be thinking about on your exams? I really hope you're saying, "Oh Divine, this sounds an awful lot like cauda equina syndrome," because it is.

This person is going to need imaging pronto. What kind of imaging do they need? I hope you're saying, "Divine, let's get an MRI."

And then that person is going to need a surgical consultation as quickly and efficiently as possible.

High C-spine Lesions

Now, what if they give you a question about an individual and they tell you that imaging shows the patient has a cervical cord lesion — let's say they got an MRI or something — and the person appears to have a cervical cord lesion at like C5 and above? And then they ask what's the most appropriate next best step in management?

I would really, really hope that you're saying, "Divine, endotracheal intubation." Why? Think about it. If you damage C5 or higher, you've messed up the phrenic nerve.

Do you remember that mnemonic you had to memorize early in med school? "C3, 4, 5 keep the diaphragm alive." "C3, 4, 5 keep the diaphragm alive."

So the cervical levels 3, 4, and 5 give supply to the phrenic nerve, and the phrenic nerve is the primary innervation to the diaphragm.

Sensory Levels

Now, maybe let me take a small sidebar here and just talk about something they love to put on exams when a person has spinal injury. When a person has injuries to the spinal cord, one thing you should really expect is something known as a sensory level.

You will notice that below a certain level, all of one or multiple kinds of sensory modalities will be lost — below the level of that lesion. They may say, "Oh, below the nipple line," that's the T4 spinal level. We know the nipple line. The person has lost all pain, pinprick, and temperature sensation.

That's a sensory level. It's almost like a sharp demarcation point in the body below which you lose all of one or more sensory modalities.

When you see sensory levels, I strongly, strongly encourage you to think about a person having spinal cord injury.

Crossed Findings

Another classic sign on the USMLE of spinal cord injury is that you're going to see pain and temperature loss on one side of the body, and then you're going to see other deficits on the other side.

What are these other deficits? Maybe deficits in vibration, fine touch, and proprioception — right, that's dorsal column territory.

You're going to see upper motor neuron symptoms contralateral to where you have the pain and temperature losses, and you're going to see lower motor neuron symptoms contralateral to where you have the pain and temperature losses.

So it's almost like on one side you'll see spinothalamic tract issues — loss of pinprick, pain, and temperature — and then on the other side you're going to see dorsal column issues — loss of fine touch, vibration, and proprioception.

You're going to see upper motor neuron symptoms again opposite to where you have the spinothalamic tract issues, and you're going to see lower motor neuron symptoms again opposite to where you see those spinothalamic tract issues.

Why is that the case?

Well, remember: the only pathway that crosses in the spinal cord — at least that you need to know for your test — is the spinothalamic tract. Remember, it crosses in the anterior white commissure, just in front of the anterior white commissure.

So it's going to give you crossed findings. But all the other pathways I've mentioned do not cross in the spinal cord. The dorsal columns do not cross in the spinal cord — they cross in the medulla.

You're going to still see ipsilateral symptoms there.

Upper motor neurons — they have already crossed in the brainstem. They cross in the caudal medulla in the medullary pyramids. So they are not crossing in the spinal cord.

So if you damage the spinal cord, you can have upper motor neuron symptoms on the same side as where you have the damage.

And your lower motor neurons? They don't cross at all. They go straight from the ventral horn of the spinal cord to the neuromuscular junction.

That's a very specific finding as well in spinal cord injury.

LMN/UMN

Another finding I found to be pretty helpful is you're going to notice that they have lower motor neuron signs in upper parts of the body and upper motor neuron signs in lower parts of the body.

I'm going to say that again: lower motor neuron signs in upper parts of the body and upper motor neuron signs in lower parts of the body.

Why does that happen? Again, when you damage a certain level of the spinal cord, you're going to mess up the lower motor neurons at that level.

That's obviously going to be elevated compared to lower levels in the body.

The lower levels in the body — the upper motor neurons are still descending towards those — so you're going to start seeing the effects of killing those upper motor neurons at lower levels.

So if you see lower motor neuron symptoms at the level of the lesion and upper motor neuron symptoms below the level of the lesion at lower levels in the body, think of spinal cord injury.

Again, I'm telling you this: these three things I mentioned — the sensory level, the lower motor neuron symptoms at upper regions of the body, and upper motor neuron symptoms at lower regions of the body — and then this thing I said about the crossed findings for the spinothalamic tract versus the ipsilateral findings in dorsal columns, the upper motor neurons, and the lower motor neurons — I'm telling you, if you see these things, you really should be thinking of some kind of spinal cord injury.

Neurogenic Shock

Now, what if they give you a question about a person that has spinal cord injury — especially like injury to the thoracic spinal cord — and then they give you that this person has very labile blood pressures, they're extremely hypotensive, they're extremely bradycardic.

Then they ask you, "Which of the following is the most likely underlying cause of this patient's abnormal vital signs?"

What should you think about?

I really hope that you're thinking about the person having neurogenic shock.

The thing is, sometimes on exams they call it spinal shock.

The thing is, when you damage certain levels of the spinal cord, you're going to pretty much destroy the sympathetic nervous system.

In fact, you may wonder, "Divine, how is it that destroying a certain level of the spinal cord is tantamount to destroying the sympathetic nervous system?"

Well, let me give you some clues here and some context.

The thing is, an old-school term that is actually used for the sympathetic nervous system is the term thoracolumbar outflow.

I'm going to say that again: thoracolumbar outflow.

Sometimes the parasympathetic system is called craniosacral because remember, your parasympathetic system works with many cranial nerves like cranial nerve 10, for example, and then some sacral nerve levels.

But your sympathetic system works with certain thoracic levels of the spinal cord and certain lumbar levels of the spinal cord. That's why it's called thoracolumbar outflow.

So if you damage the spinal cord, especially at the thoracic levels, you can go into shock because your sympathetic nervous system has basically been severed.

And then your parasympathetic system is basically working on a post.

So the thing is, what are some things the sympathetic nervous system does for us? Well, it does things like constriction of vessels — both arteries and veins.

So if your sympathetic nervous system is gone, you won't have that vasomotor tone.

So let's start looking at some of the consequences of that problem:

Like, for example, if you cannot constrict your veins — remember, you need to constrict your veins — you need venous constriction to send blood back to the heart.

Those veins need to be constricted for blood to be sent back to the heart.

But if you cannot constrict your veins, you literally will not be able to send blood back to the heart.

And if you can't, what happens to your preload? Your preload drops like a stone.

So you can pretty much say bye-bye to preload.

And here's the thing: if you have no preload, are you going to have any kind of cardiac output? No. Your cardiac output is going to reduce.

Now let's look at things from the arterial side.

If you don't have constriction of your arterial bed, are you going to have any kind of afterload? No.

Your systemic vascular resistance is going to plummet.

And think about it: if your parasympathetic nervous system is basically working on a post, what do you think is going to happen to your heart rate?

Your heart rate actually is going to be low. You're going to be bradycardic. You're going to be bradycardic.

The reason I like to explain things is that when we start talking about treatments, it's going to make way more sense.So, for example, how do you think we manage neurogenic shock? Well, give them fluids. Fluids are going to help with this preload problem that they have.

Give them atropine. Atropine is a muscarinic antagonist. It's going to speed up conduction down the AV node. It's going to help with the bradycardia.

And then these people don't have vascular tone. They don't have constrictive tone.

So for those people, give them a pressor like norepinephrine. It's going to clamp down on their vessels and it's going to help with giving them vascular tone.

C-spine Fracture and Imaging

Now, let's go to something else. There's kind of like a bizarre question that our friends at the NBME may throw on an exam.

So they may say that you have some patient that fell from a height, and a cervical X-ray was conducted on them.

Sometimes instead of cervical X-ray, they may use the term cervical survey.

And they'll say, "Oh, imaging discloses a C-spine fracture or cervical spine fracture," and then they will ask you, "What is the most appropriate next best step in management?"

I can almost promise you they will give you an answer that says to go to the operating room.

But then there will be another answer that says to get further imaging of the spine.

Let me tell you something: pick the answer choice that says to get further imaging of the spine, especially the lumbar spine and the thoracic spine.

See, let me tell you something: whenever you have damage to the cervical spine, look for fractures elsewhere.

In fact, in about one-fifth of cases of cervical spine fractures, you're going to find fractures in the thoracic spinal cord and in the lumbar spinal cord.

This is very important.

Again, they will try to make you pick surgery first, but know all the fractures that exist before jumping to surgery.

Why go to surgery and then start encountering fractures you did not expect, or having to take the person to the OR twice?

It doesn't make any sense.

The only time you should pick the answer that says to go to surgery is if you don't see an answer choice that says to get further imaging of the thoracic and lumbar spine.

Again, it's kind of a weird question.

This is one of those things you probably will never find in any resource, but this stuff is very, very high-yield to know for your exams.

Trauma Deaths

Now, my next question for you is this:

What is going to be the most common — this is like an epidemiology question — what is the most common region of trauma that leads to trauma-related deaths?

So just looking in terms of regions of the body.

Because they can give you a non-specific question about a person that is involved in trauma, and then they will say, "Oh," and they will give you like, "This person has trauma in many regions: in the chest — in the thoracic region, in the abdominal region, they have extremity injuries," and whatnot.

And then they will say, "Oh, which of the following will be the most likely cause of mortality in this patient?"

This is a straight-up "you either know it or you don't" kind of question.

If you want to pick an answer on your test, pick the answer that talks about chest trauma.

Most people that die from trauma die from issues within the chest.

Why? Well, the reasoning there is that there are just way too many high-value organs within your chest or within your thoracic cavity.

I mean, obviously, there's your heart.

Then there's your lungs.

And also, a big problem is there are a lot of high-value blood vessels in your chest.

Like what? Like your aorta.

You see many people — they have like high-speed trauma and they transect the aorta, and that's obviously almost like a death sentence with very few exceptions.

Foreign Body in Child

Now, what if they give you a question on your exam about a child that was kind of playing with toys, and then that child is found unresponsive within a few minutes?

His dad notices him, like, "Wow, he was playing happily with his toys like 10 minutes ago," and then he just found him suddenly being unresponsive.

What's your diagnosis on your exam?

I hope you're saying, "Divine, this is actually a foreign body ingestion."

And then they ask you, "Oh, the patient is brought to the emergency room," or whatever, and then you are asked, "Which of the following is the most appropriate next best step in management?"

Well, I would really hope you're saying, "Oh, Divine, I'm going to go ahead and perform flexible laryngoscopy."

And then they ask you, "What is the most likely side of aspiration of this foreign body?"

I would hope you're going to pick the answer that says the right mainstem bronchus.

Remember, the right mainstem bronchus is wider and is more vertical than the left mainstem bronchus.

So if you aspirate something, it is going to go into the right mainstem bronchus.

Again, this is a very, very nice anatomy integration from Step 1.

Tension Pneumothorax

Now, what if they give you a question about an individual that has sudden onset shortness of breath after an EGD — after an esophagogastroduodenoscopy — and they tell you that this person is profoundly hypotensive and that this person has unilaterally absent breath sounds?

I'm sure many of you know exactly what this is.

This is going to be a tension pneumothorax.

And many of you have probably memorized that, "Ooh, the most appropriate next best step in management is to do some kind of needle thoracostomy."

Needle thoracostomy, which we call a needle decompression.

Now, let me tell you this: the NBME, they are not stupid. They know that most of you listening to this podcast, most of you taking the exam, have memorized this.

So what kind of supplemental question may you see with stuff like this?

Well, they can ask you a subsequent question.

In fact, they can make this a two-part question.

They'll make your life easy for the first part — pick needle thoracostomy as the answer, or whatever.

But they can ask you — and see, they can make this into another big question — "Where do you insert the needle in needle thoracostomy?"

I really hope that you're picking the answer that says to insert the needle in the second intercostal space in the midclavicular line.

And remember, you want to insert that needle above the rib, not below the rib.

Above the rib, not below the rib.

So you probably want to insert it just above rib 3.

Because remember, the second intercostal space is below rib 2, but you don't want to go directly below because that's where the intercostal vessels, the intercostal vein, the intercostal artery, and the intercostal nerve run.

You want to go just above rib 3.

Because just above rib 3, that's still the second intercostal space.

That's still in the midclavicular line.

You're going just above the rib so that you can spare damage to the intercostal vessels.

After you have done the needle thoracostomy, your next step on the exam will be to place a chest tube for a tension pneumothorax.

You will place a chest tube, which we also call a tube thoracostomy. You want to do that to more conclusively deal with the problem. Because remember, needle decompression basically just buys you time. It converts the pneumothorax from a very dangerous kind to a less dangerous kind. It converts it from a tension pneumothorax to an open pneumothorax.

You're primarily just creating a less worse pneumothorax.

So you need to do definitive management with a chest tube — which again, we call tube thoracostomy.

Again, you'll be quite amazed at the number of applied anatomy questions that our friends at the NBME love to throw on the EM shelf, the surgery shelf, and Step 2 and Step 3 as well.

Chest Movement

Now, the next question I want to go into — I'm going to discuss this from kind of a weird perspective — but how is the chest supposed to move during the respiratory cycle? What do you think? Your chest wall — your chest — is supposed to move outward with inhalation and inward with exhalation. So it should move externally with inhalation, and it should move internally with exhalation. Just remember: your E's and I's are flipped, and you're going to be good to go. Literally try this out with your chest: take in a deep breath — you see, your chest gets bigger. Blow it out — you see, your chest kind of goes in. So as you exhale, your chest goes inward.

As you inhale, your chest goes outward. Again, don't just memorize something you can easily understand and just prove with an easy physical exam on yourself.

Flail Chest

So now that I've given that foundation, imagine they give you a trauma question and they tell you that the patient has severe chest pain, severe shortness of breath, the patient is very hypoxic. And then they tell you that on inspiration, the person has an inward-moving chest.

And on expiration, the person has an outward-moving chest. Oh, that's not good. This person's chest is moving paradoxically. This person's chest is moving contrary to what you would expect.

What should you be thinking about on your exams? What diagnosis should you entertain? I would really hope you're saying, "Oh, Divine, this person likely has something called a flail chest." How is flail spelled? Flail is spelled as F-L-A-I-L. Flail chest.

Usually, you're going to see this when you've had more than two rib fractures, and for each of those ribs that you've fractured, you fracture them in multiple places.

So you may think that this is not a big deal, but this is actually a really big deal.

This stuff is actually super dangerous because you have these rib fragments that can literally start slicing and dicing your lungs — injuring your lungs.

In fact, the most common cause of death — we can even say the most common cause of morbidity — in a person with flail chest is a pulmonary contusion.

So how do we manage these people that have flail chest? Well, number one: give them oxygen. Number two: give them fluids — give them judicious fluid replenishment. Number three: give them pain control. For most people, this is going to work. But if these people keep crashing and they're not getting better, then you want to strongly consider some kind of positive pressure ventilation, like endotracheal intubation for these folks.

Jugular Vein

Now, let's talk about another physiological phenomenon.

I kind of want to use these to discuss in this podcast.

So normally, when you take in a deep breath — when you inhale, when you inspire — what happens to your jugular veins?

Are they supposed to relax or are they supposed to expand?

I hope you're saying, "Divine, your jugular veins are supposed to relax on inspiration."

Well, why does that make any sense?

Well, that makes sense because when you inhale — think about it — I said hey, on inhalation, your chest wall moves outward.

Your chest wall is moving outward; your diaphragm is going down.

So what's happening to your intrathoracic volume?

Your intrathoracic volume is increasing.

And if you remember Boyle's law — that pesky Boyle's law that they had you memorizing in college — as volume increases, what do you think happens to pressure?

Pressure is going to go down. Remember, volume and pressure are inversely related. So your pressure is going to go down. So your intrathoracic pressures go down. And if your intrathoracic pressures go down, everything within the thorax is going to be at a lower pressure.

You're creating a low-pressure system for many things in the thorax. That's why, for example, air rushes into your lungs — because remember, flow happens from high pressure to low pressure.

So since you've made your lungs a lower-pressure system, air is going to rush in.

Now, what other big organ is in the thorax? Well, it's going to be your heart.

Well, since your heart is now a low-pressure system, blood is going to be willing to rush into that heart. Blood is going to rush in from every vein possible — for example, from your jugular veins.

So if blood is rushing from your jugular veins into the heart because the heart is now at a lower pressure, then your jugular veins — blood is being emptied from them. So it's supposed to collapse. That's the normal situation.

Kussmaul's Sign

But let's say you inspire, and you actually have an expansion of your jugular veins instead of a collapse of your jugular veins.

What should you be thinking about on your test?

I would hope you're saying, "Divine, that's what we call Kussmaul's sign."

And let me tell you something here: you're going to see Kussmaul's sign whenever you have a situation with your pericardium.

Whenever you have a situation with your pericardium or your pericardial space.

Because basically, those things will prevent the heart from relaxing.

You're like, "Oh, I'm inspiring, I'm inspiring, I'm inspiring — so my heart is becoming a low-pressure system."

Well, not so fast.

If, for example, your heart cannot relax — say, for example, you have constrictive pericarditis when you've calcified the walls of the pericardium — or say, for example, you have tamponade, where you have all this fluid that has filled up your pericardial space.

When you have those things, you will have Kussmaul's sign.

Because even if you are inhaling — even if you're inspiring — your heart cannot relax because there's just stuff that's literally compressing and preventing its relaxation, preventing it from chilling out from the outside.

So don't forget: constrictive pericarditis can absolutely cause Kussmaul's sign.

That's probably the most common cause of Kussmaul's sign on the USMLE.

But do not forget that Kussmaul's sign may also be found with cardiac tamponade..

Remember, for cardiac tamponade, you're going to do a pericardiocentesis, and you're going to give them fluids.

Fluids are a big part of the management of cardiac tamponade.

You want to try to force in as much fluid as possible into their hearts so that you can maintain their blood pressures.